

DISCUSSION
PAPER

REMOTE BUT PRODUCTIVE

Practical lessons on productive
uses of energy in Tanzania



Hivos
people unlimited

iied

DISCUSSION
PAPER

REMOTE

BUT PRODUCTIVE

Practical lessons on productive
uses of energy in Tanzania

Energy Change Lab works with pioneers and changemakers in Tanzania to build sustainable, people-centred energy systems.

Our productive uses of energy (PUE) programme helps rural communities increase their incomes and productivity.

This paper describes our work with two mini-grid developers to develop and test practical approaches for improving PUE uptake in rural villages through prototypes to build skills and sustainable supply chains.

We hope that lessons from this work — including the importance of trust, community engagement and linking into national financing schemes — will help build knowledge and partnerships and scale up the impacts of PUE in Tanzania.

CONTENTS

Overview	7
The Energy Change Lab's Process	10
What is Prototyping?	10
Prototype 1: bridging the skills gap	13
Using PUE champions and tools to bridge the skills gap	14
Results from Prototype 1 and looking forward	17
Prototype 2: sustainable appliance chains	20
Expanding appliance supply chains and after-sales servicing to rural communities	20
Distribution and after-sales prototyping	21
Results from Prototype 2 and looking forward	24
Lessons and recommendations from both prototyping interventions	27
Looking forward	32
Annex A: the Change Lab process for prototyping PUE	33
Annex B: list of key PUE stakeholders in Tanzania	34
References	37

Acronyms

CEFA	European Committee for Training and Agriculture
E4I	Energy 4 Impact
MFI	microfinancing institution
PUE	productive uses of energy
SME	small and medium-sized enterprise
ToT	training of trainers
VETA	Vocational and Education Training Authority
VICOBA	village community bank

Overview

The Energy Change Lab (the Lab) is an IIED and Hivos programme that works with pioneers and changemakers in Tanzania to build a sustainable, people-centred energy system. It develops leaders, incubates prototypes for sector change, builds evidence, connects people and shares ideas.^{1,2} One of its key themes – productive uses of energy (PUE) – looks at using electricity as an input to increase income or productivity.

Funded by the Charles Stewart Mott Foundation and the Dutch Ministry of Foreign Affairs, the Lab's PUE programme helps pioneers in and outside the energy sector to prototype ideas and solutions. The Lab uses prototyping – a process of designing, testing, learning from and feeding back ideas into iterations and partnerships that can jumpstart these activities in local communities – to catalyse know-how to scale.

Initiatives to build electricity demand in remote communities must also develop reliable and affordable energy delivery systems. Getting local businesses to productively use energy is a key part of building this demand and enhancing livelihoods to benefit community economic development. PUE covers a range of goods and services, including fabrication (welding machines and carpentry saws) and agro-processing (refrigeration, milling and grinding machines).

But many rural communities express low initial demand for energy. So mini-grid developers face the simultaneous challenges of installing affordable and reliable energy delivery systems while also stimulating demand for electricity. Crucially, energy delivery systems must have built-in elements for PUE.

In 2016, the Lab conducted field research to better understand some of the models and drivers for being remote but productive in the Tanzanian context. The Lab's findings on accelerating PUE included the need for enabling policies, increased cross-sector coordination, tailored financial products and incentives and advisory support.^{3,4} Others working in Tanzania have been exploring PUE in parallel. For example, Energy 4 Impact (E4I) have increased community entrepreneurial capacity, building their evidence case around businesses using PUE equipment;⁵ and PowerCorner is testing a tariff subsidy to see how it affects electricity demand, with funding from Rockefeller and support from Crossboundary.

To foster and accelerate learning between developers and other important stakeholders such as the government, financing institutes and non-profits, the Lab mapped and interviewed key stakeholders to identify their perceptions

on gaps in fostering PUE. These included financing, skills for local entrepreneurs, last mile distribution of PUE appliances and after-sale services.

To further sector-level discussions and learning, the Lab ran a safe-space dialogue through four well-attended multi-sectoral PUE exchanges. These took place in Dar es Salaam (May 2016, July 2017 and November 2018) and Dodoma (July 2018). Stakeholders agreed on partnerships and called for more guidance and platforms for collaboration on PUE.^{3,6}

The second of these – the 'Productive use of energy: problem solving and innovation workshop' in Dar es Salaam – brought together 46 off-grid experts and stakeholders. After exploring critical problems in designing and implementing energy services or investments that target productive activities, participants developed different prototyping ideas.⁷

Grounded in this extensive background evidence and dialogue process, the Lab has since worked with two mini-grid developers – PowerCorner and Rafiki Power – using an action-research rapid prototyping method that develops and tests practical approaches on the ground for improving PUE uptake. We brought lessons from this back to the dialogue process for wider uptake and discussion on supporting enabling-environment measures. This report highlights key findings from the implementation of the two prototypes.

The prototype interventions fall under two themes:

1. Bridging the skills gap: Many local businesses (or potential entrepreneurs) lack the skills they need to start up and run their businesses effectively. These include identifying business opportunities, basic business management skills, financial planning, record keeping and equipment use and maintenance. Classroom-style training is often not effective, so we developed locally appropriate



Jamal shapes a piece of wood on his wood lathe in his workshop in Nakopi community

training materials (including videos in Kiswahili), combined training sessions with follow-up mentoring and developed a local network of PUE champions to catalyse peer-to-peer learning. We documented the know-how of doing this so others can take up and replicate the approach for different business models.

2. Sustainable appliance supply chains: Few appliance distributors can offer their products and services to rural areas, which are often remote and lack basic infrastructure such as paved roads. This prototype aimed to integrate the actors in the last mile distribution of PUE appliances – financial institutions, equipment suppliers, transporters, distributors, local technicians, sales agents and village community banks – to work out incentives to serve rural villages.

Key learning from implementing the prototypes includes:

- Building partnerships between specialised stakeholders – mini-grid developers, training and finance institutes, appliance suppliers and so on – who normally operate in different spheres is crucial for developing the necessary components for establishing PUE. These partnerships build on existing expertise and institutional reach. Aligning incentives for stakeholders will be crucial in this respect
- Some actors along the appliance and equipment distribution chain are willing to engage but need de-risking mechanisms, such as guarantees. The Lab's support and guidance helped build trust and buy-in for all stakeholders, which will be needed in future efforts to build out distribution chains more quickly
- A package of capacity building, PUE demonstrations, mentorship, access to finance and appliances as well as training tools in Kiswahili helped the Lab's PUE champions and entrepreneurs succeed. Figuring out when to apply certain mixes across communities with varying characteristics will be critical in building up viable PUE development pathways, using the partnerships mentioned above, and
- Linking PUE into existing national schemes, such as the National Economic Empowerment Council's (NEEC) guarantee for small entrepreneurs, could help more rapidly unlock PUE through government supported empowerment and small industrialisation initiatives.

There is still much work to do. The Lab's aim is to establish a holistic and practical 'how-to' approach for catalysing PUE that work for specific local contexts. This could include building partnerships to tailor and apply a combination of capacity building, longer-term mentorship, financial access and linking PUE appliance distribution chains.

We need to collect more experimental evidence and data to develop this holistic approach and test its effectiveness for replication and scale. Close sector coordination and new partnerships are also necessary to catalyse PUE at scale.

The Lab will be working with others to further build knowledge, partnerships and scale impacts going forward to enable people in remote areas to productively use energy.

THE ENERGY

CHANGE LAB'S

PROCESS

THE ENERGY CHANGE LAB'S PROCESS

© The Energy Change Lab



Participants from the Peer to Peer Learning Workshop in Dodoma in July 2018 pose in front of Rafiki Power's distribution hub

Across many countries aiming to establish more and better energy access for citizens, a complex web of interrelated and wide-ranging issues impedes development of the sector. In many countries, the political will for energy access does not translate quickly into the development of energy access and better power on the ground. Some often cited examples of barriers include: top-down planning that often fails to grasp local realities and characteristics; limited coordination where energy sector stakeholders work separately from other sector actors such as finance and training institutes; capacity gaps in technical and business skills limit the impacts of initial product and project installation; and limited consumer engagement in the policy debate.

To contribute to addressing these issues, the Energy Change Lab uses a phased multi-stakeholder process that follows a problem analysis into ideation and implementation through prototyping of solutions with partners. This social innovation process sees stakeholders partnering to build sustainable and equitable solutions. The lab works on multiple levels and aims to build capacity in people and networks that nurture sustainable solutions themselves. Through this process, innovations and breakthroughs happen by engaging, enabling, and connecting pioneering people and organisations. After prototyping solutions with partners, these partnerships and knowledge are unleashed through the scaling of partnerships, sector exchanges, and advocacy engagements with relevant stakeholders like the government.

The Lab's process is designed to create a conducive environment for trust-building and innovation. Figure 1 highlights the Lab's process in full, from defining impediments to unleashing solutions. See Annex A for more detailed information on the Lab's process and methodology.

What is prototyping?

This document highlights Phase 4 of the Lab's process: prototyping. The process of prototyping is simply the rapid implementation of activities built on learnings from background research combined with dialogue and engagement with energy stakeholders and experts from earlier phases of the Lab's process. Over the course of implementation, the Lab adjusted the prototypes using ongoing feedback from communities and partners through meetings and dialogues. For PUE, the Lab's research and sector dialogues highlighted numerous barriers such as limited access to finance for entrepreneurs and the skills gap stopping community businesses from thriving. Feedback from PUE stakeholders guided rapid adjustments in the experimentation. For example, Prototype 1 in this document moved from simply establishing a network of PUE champions and building skills, into adjusting the enabling environment such as tariff reductions and accessing appliances to allow this network to thrive.

After exploring multiple partnerships and ideas in earlier phases (see breakout box), the Lab connected with Rafiki Power and PowerCorner, two mini-grid developers operating

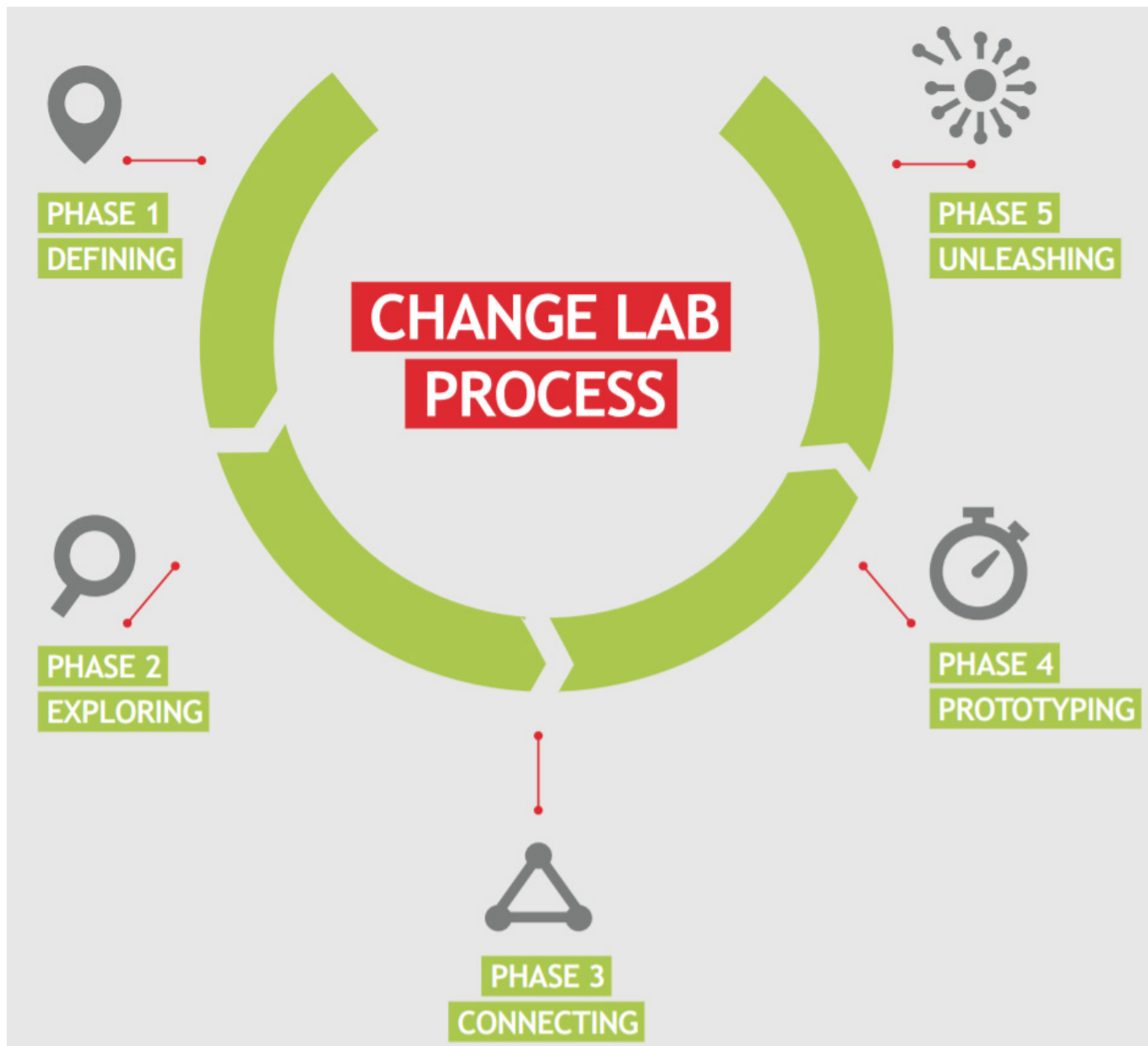


Figure 1: The Energy Change Lab’s multi-stakeholder process for identifying problems and enabling stakeholders to overcome them

After conducting extensive research on PUE in Tanzania,³ the Lab sought to convene the off-grid sector to share learnings between peers and push forward various prototyping ideas for PUE. In July 2017, the Lab hosted a ‘PUE – problem solving and innovation workshop’ in Dar es Salaam, which convened 46 participants from government agencies, energy providers, policy influencers, donors, MFIs, research institutions and other sectors. The workshop helped inform and validate the Lab’s strategy, while participants highlighted critical barriers for PUE and established ideas for partnerships and prototypes to overcome them.⁸ Our partnerships with mini-grid developers PowerCorner and Rafiki Power emerged from this workshop.

in Tanzania. Both wanted to work with the Lab to parse out two prototypes to bridge the skills gap and build sustainable appliance supply chains in their targeted communities.

The Lab started the prototyping process through deep engagement with community stakeholders – local government authorities, technicians, entrepreneurs and microfinancing institutions (MFIs) – training institutes and PUE appliance suppliers. Discussions focused on exploring PUE skill requirements and identifying those that were missing; appliance supply chains; collecting information; and identifying potential partnerships at community level.

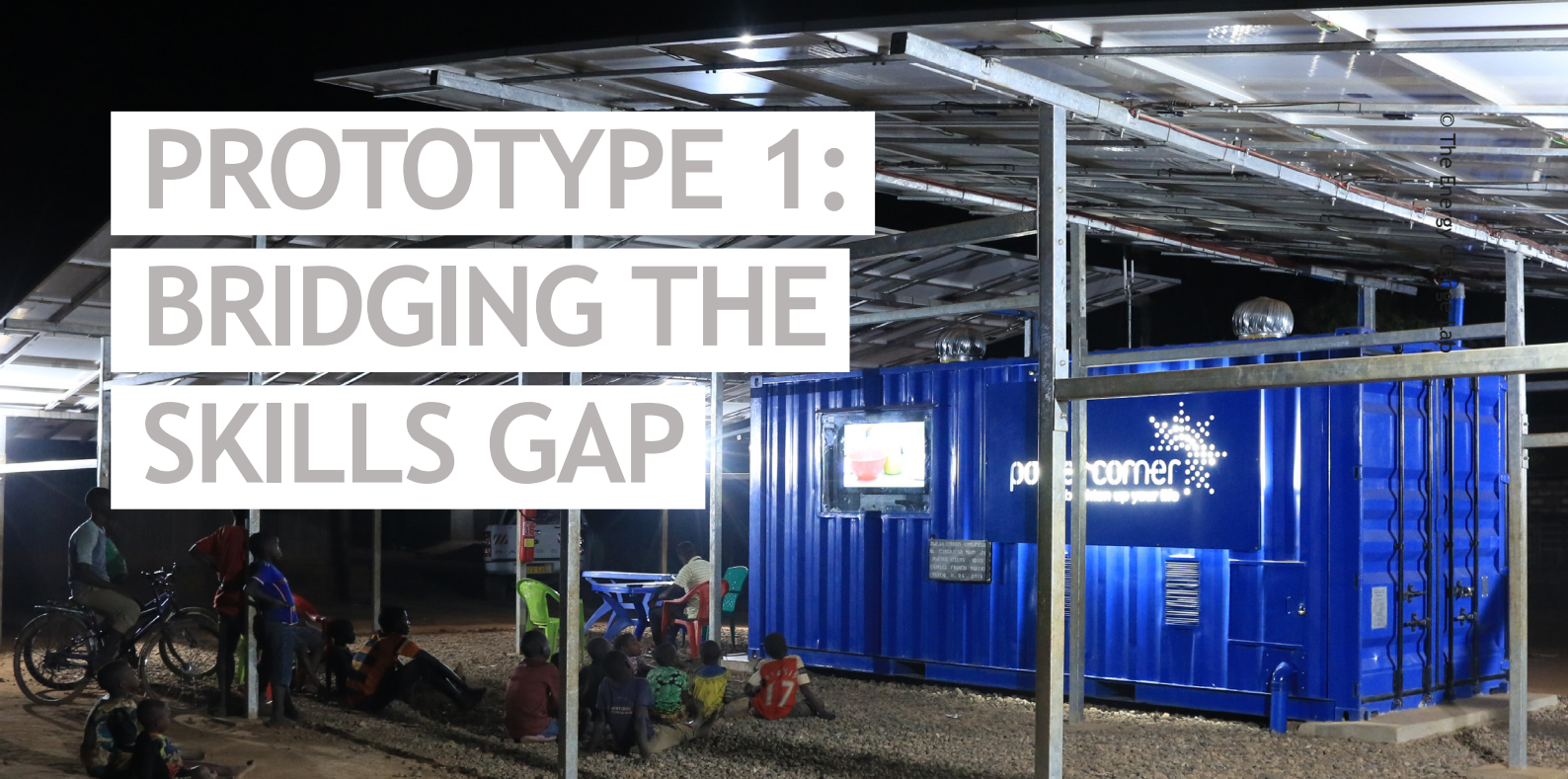
The text in the following sections highlights the prototyping process and what the future holds for these projects and the Lab at large.

PROTOTYPE 1:

BRIDGING THE

SKILLS GAP

PROTOTYPE 1: BRIDGING THE SKILLS GAP



PowerCorner generation hub showing one of the Lab's PUE video tutorials in Mbaya community

PowerCorner, a Tanzanian-based mini-grid developer and internal start-up of the ENGIE Group, established its first mini-grid in 2015 in Ketumbeine community in the Longido district. By the end of 2018, PowerCorner had eight operational mini-grids in Tanzania serving 1,500 customers and an additional four mini-grids planned for commissioning in early 2019. PowerCorner uses prepaid meters and mobile money technologies to reduce its operations costs.

For this prototype, PowerCorner wanted to use mini-grids planned for Barikiwa, Mbaya, and Nakopi communities in Liwale and Nanyumbu districts. All three sites were 20-40km from the national electricity grid and had higher population densities towards the town centres. Typical of many rural Tanzanian communities, they are made up almost exclusively of farmers, who work cashew, maize, cassava, millet and sesame crops. The remaining fraction of the

working population works in dispensaries, schools and local government offices. A few households also raise livestock and engage in entrepreneurial activities. The Lab's baseline information showed that the average annual income was US\$220-650 (TZS 500,000-1.5 million) in Barikiwa and Mbaya and US\$170-650 (TZS 400,000-1.5 million) in Nakopi. After careful consultation with PowerCorner, the Lab established this prototype to address the capacity gap

Table 1: Mini grids operational in the prototyping area

Village	District	Region	Capacity	Number of households	Number of connections	PUE customers
Barikiwa	Liwale	Lindi	30kW	482	245	12
Mbaya	Liwale	Lindi	30kW	334	203	10
Nakopi	Nanyumbu	Mtwara	30kW	379	245	16

Source: PowerCorner (2018)

identified by community entrepreneurs at the three mini-grid sites, which included a lack of:

- a. Knowledge to make informed equipment and appliance purchasing decisions
- b. Technical skills to operate new equipment, and
- c. Entrepreneurial and business skills to manage small business operations.

The Lab also developed training materials adapted from ENERGIA's 2014 manual on PUE and business development



Figure 2: The Lab's activities concentrated in the south for this prototype

skills, which views PUE development in rural communities through a gender lens.⁹ As a nongovernmental organisation bringing empowerment, equality, and inclusivity into energy projects, ENERGIA's manuals are comprehensive and a good foundation to ensure inclusive energy activities. As an essential part of the Lab's programming, the manual's focus on gender ensured that the prototyping did not reinforce the status quo of gender imbalance. The adapted manual is in Kiswahili and focuses on PUE, business development and occupational health and safety. Sections include:

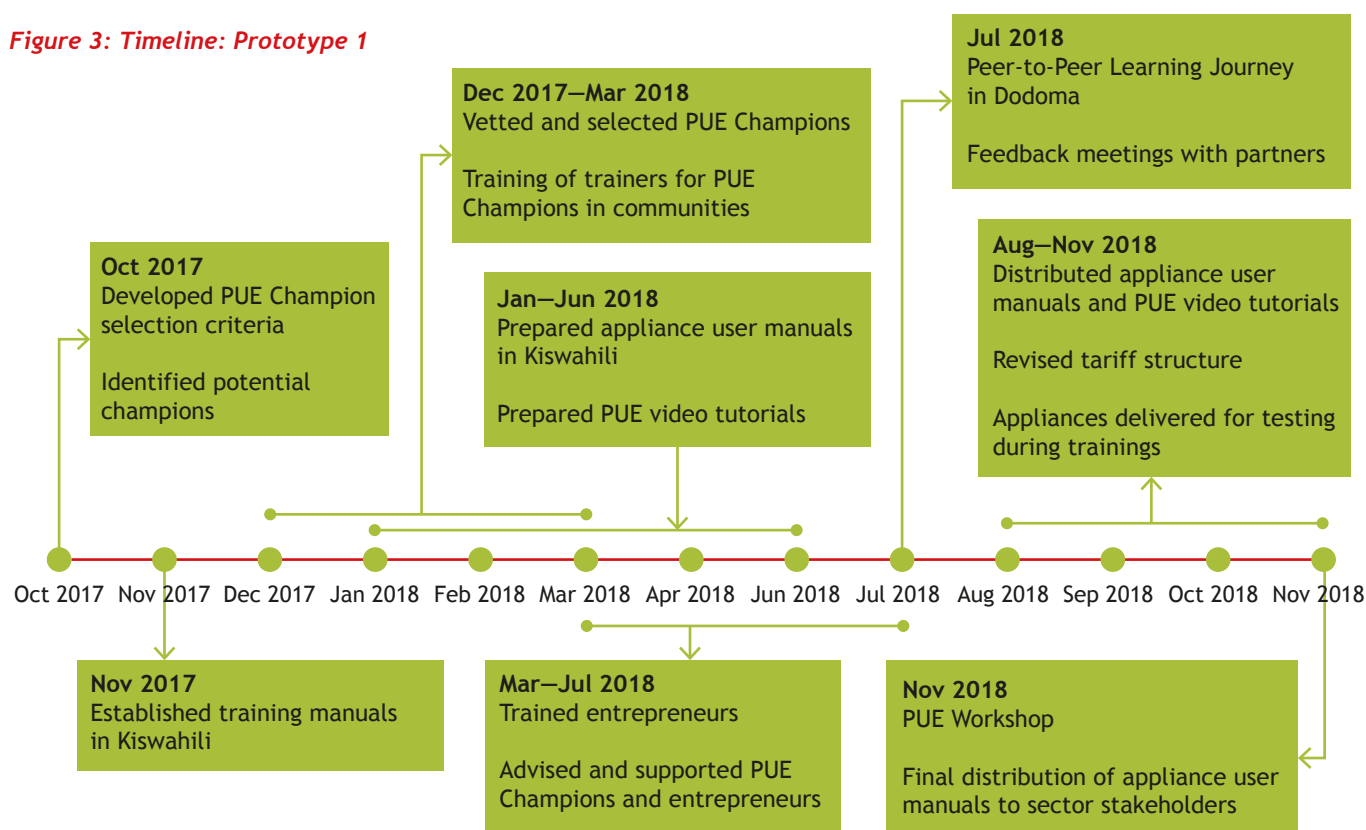
- How to identify business opportunities
- Basic business management skills
- Financial planning
- Record keeping
- Health and safety standards

In addition, the Lab added a hands-on session demonstrating how to use a blender utilising locally available fruit (see Figure 3).

Using PUE champions and tools to bridge the skills gap

In October 2017, the Lab consulted the selected communities to help identify appropriate criteria and candidates for community change agents called PUE champions. The selection criteria focused on the skills and attributes needed to establish a successful business and to train and mentor other local PUE entrepreneurs. Under this prototype, the Lab would train this network of PUE champions to develop their own PUE businesses and

Figure 3: Timeline: Prototype 1





The Energy Change Lab's Frederick Mushi demonstrates a juice blender to Zainabu and Fanyeni, in Barikiwa Village

support other community members to develop their own. Ideal candidates would:

- Have an established business or viable business idea that used electricity as an input
- Have some prior technical/vocational skills as well as basic literacy and communication skills
- Be prepared and committed to mobilise own resources to realise their business
- Have a good reputation and well known by community members, and
- Have interest and time to teach and motivate other community members on PUE.

At this time, PowerCorner had not fully installed the mini-grid infrastructure in the selected communities. As a result, people hesitated to commit to the training as well as investing in their businesses. But once PowerCorner commissioned the mini-grids, the prospective PUE champions saw the potential and invested in the prototype. The Lab ran a two-day training of trainers (ToT) in Barikiwa in December 2017. Once Mbaya and Nakopi communities also had operational mini-grids, the Lab facilitated ToTs in March and April 2018 respectively. In total, the Lab trained 60 community members (43 men and 17 women) across the three sites.

Selecting PUE technology and champions

Based on market assessments, the Lab and PowerCorner identified eight technology areas with high PUE potential at the three sites including metalworking, repair workshop, tailoring, refrigeration, hair salons, food processing (meat grinding, popcorn making, ice-cream making, blending), agro-processing and woodworking. After the initial ToTs, the Lab and PowerCorner selected eight PUE champions for each mini-grid site – one for each of the eight technologies.

Table 2: PUE champions breakdown by community and gender

Communities	Female	Male	Total
Barikiwa	3	5	8
Mbaya	3	5	8
Nakopi	1	7	8
Total	7	17	24

Training tools for PUE champions

To help PUE champions cascade the training in their communities, the Lab collaborated with the Vocational and Education Training Authority (VETA) and experienced PUE entrepreneurs to develop five intuitive, user-friendly manuals for PUE appliances in Kiswahili and English as well as five video tutorials in Kiswahili with English subtitles. The manuals included a popcorn machine, juice blender, hair dryer, meat grinder and welding machine and the videos were on welding, popcorn making, juice making, using air compressors and occupational health and safety.

For these training materials, the Lab avoided PUE activities that many entrepreneurs had prior knowledge or experience with – such as refrigeration, tailoring or milling – as well as activities such as agro-processing machinery that were not compatible with the smaller mini-grid sizing at the PowerCorner sites. It also considered female and male preferences – juice blending, meat grinding, hair drying and popcorn making for the former; popcorn making and welding for the latter – in line with the ENERGIA's gender lensing manual. Additionally, PowerCorner tested the selected appliances on the mini-grid infrastructure to ensure compatibility.

Communities, mini-grid developers and other stakeholders gave feedback on the draft materials – for example,

during the peer-to-peer learning workshop in July 2018 in Dodoma – and the Lab distributed the finalised training tools in November 2018.

Peer-to-peer learning, feedback and iterations

The Lab received ongoing feedback from communities and partners over the course of the prototyping and hosted workshops to take stock of the prototyping process. This feedback helped shape prototyping changes and iterations. The Dodoma peer-to-peer learning workshop in July 2018 generated valuable feedback from stakeholders, which the Lab used in discussions with prototyping partners. For example, PowerCorner and the Lab identified that the higher tariff structures associated with mini-grids limited entrepreneurs' ability to invest in their businesses and adhere to appliance payments. After consultations, PowerCorner agreed to revise their tariff structure, introducing new tariffs for businesses that operate 24 hours a day – such as egg incubators – and increasing the large tariff bundle from 300W to 1,000W. These changes made electricity more affordable for entrepreneurs while ensuring more consistent demand for mini-grid services.



Day 2 of the peer-to-peer learning workshop featured a trip to Chang'ombe Village (Rafiki Power site). Shukuru, a welder in the community, explains successes and challenges to participants

Tulia, an eager entrepreneur in Barikiwa struggled to afford the tariff for her new blender, which required 350W of power. This power requirement nudged her into a higher tariff level under the original PowerCorner tariff scheme, which required an extra US\$43 (TZS 118,000) fee. After the Lab's peer-to-peer learning events and community consultations, to accommodate more PUE, PowerCorner raised the tariff threshold from 300W to 1,000W. The restructured tariff scheme allowed Tulia to afford the electricity inputs to power her blender. She now has a successful fresh juice business that uses locally available fruits.

Source: The Energy Change Lab

Additional feedback from communities noted that focusing on capacity building alone was not enough; hands-on appliance demonstrations helped increase buy-in and inform entrepreneurs' decision-making. Consequently, PowerCorner agreed to go ahead and purchase appliances specifically for training and demonstration purposes.

Using the four training appliances provided by PowerCorner – a popcorn machine, welding machine, wood lathe and air compressor – the Lab ran further on-site demonstrations in August 2018. Immediately following the demonstrations, four entrepreneurs invested in an air compressor, welding machine, and two popcorn machines respectively from PowerCorner. PowerCorner who had a limited stock of appliances available on a rolling basis (see Prototype 2 for more supply chain work). Six weeks after the training, entrepreneurs invested and established an additional five business applications (wood lathing, two more popcorn machines, and a juice blender). The Lab's trainings and demonstrations gave entrepreneurs the skills and informed decision-making power that they needed to invest. The rapid experimentation and testing, for example in restructured tariffs, further enabled entrepreneurs to establish viable businesses. The Lab hosted a video show at night where community members watched the PUE video tutorials. Participants gave very positive feedback on the educational content and quality. Using evidence from this prototype, PowerCorner now uses demonstrations to increase appliance uptake in mini-grid communities.

The harvest season is usually the time of year when local economies are more flush with cash, meaning entrepreneurs can better afford the down payments they need to start their PUE-powered businesses. However, ongoing issues revolving around agricultural crops constrained local economies and entrepreneurs' abilities to invest. But upcoming harvest seasons afford more opportunities for PowerCorner and other mini-grid developers to market and demonstrate appliances and promote skills training.

PowerCorner is now working to implement other PUE projects and applications such as water irrigation, milk processing, agro-processing machinery, WiFi hotspots and electric bikes across its mini-grid sites.

Ongoing support for PUE champions

After the training of trainer sessions, the Lab continued to monitor and provide crucial support to selected PUE champions through follow-on workshops distributing the manuals and videos, appropriate PUE appliance selection, other business advisory services and continuing on-site training and advice.



Issa demonstrates a popcorn machine demonstration for community members in Barikiwa Village

Results from Prototype 1 and looking forward

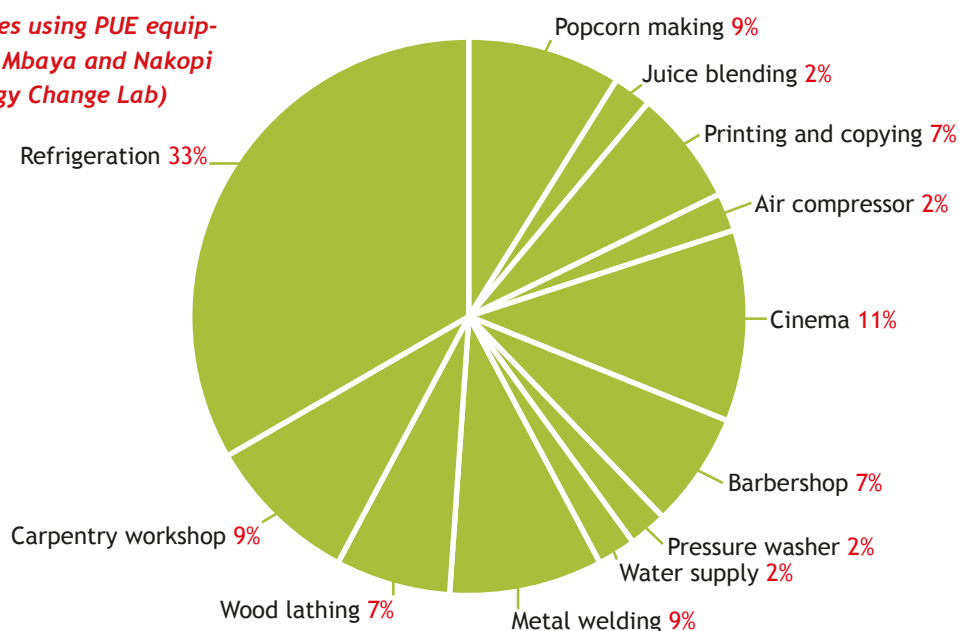
This prototype showed how strong partnerships and an iterative approach to complex PUE problems can generate gains in short periods by pooling resources and ideas. By working closely with partners who have ongoing operations and interest in PUE development, the Lab could experiment and iterate rapidly to test new ideas and approaches. Lessons learned in one community could be quickly applied to other sites.

This prototype achieved a lot using limited resources and in a condensed time span. Entrepreneurs and PUE champions

gave very positive feedback on the training content and courses in Kiswahili. They also found the demonstrations of appliances particularly useful in grounding the concepts and requested further demonstrations of other appliances for hands-on training to explore other business opportunities. Indeed, based on evidence from this prototype, these demonstrations have good potential to catalyse PUE and rural development in Tanzania.

PUE champion networks show promise. Fifteen PUE champions established their own businesses and cascaded training to 52 entrepreneurs (32 men and 20 women) who are operating 45 PUE businesses and employing 49 people. Figure 7 shows that, of the 45 business established in

Figure 4: Businesses using PUE equipment in Barikiwa, Mbaya and Nakopi
(Source: The Energy Change Lab)



the three PowerCorner communities, refrigeration was the most popular (15), followed by cinemas (5), welding (4), carpentry (4) and popcorn making (4). These businesses earn entrepreneurs a monthly income of US\$60–200.

Four especially innovative PUE champions trained 31 of the 45 entrepreneurs – mostly in welding, tailoring and carpentry – and charged for training services rendered. The 11 other PUE champions trained entrepreneurs for free, often motivated by their close relationship and/or a plan to engage them in their own businesses. Nine PUE Champions could not afford the 25 per cent down payment to purchase appliances but planned to do so during the next harvest season.

Moving forward, PowerCorner plans to continue using the PUE champions' expertise. As the company expands appliance access in communities, it is working with the PUE champions to deliver equipment and help community entrepreneurs with initial setup, demonstration, usage and mentorship. The champions receive compensation, usually in cash, directly from the entrepreneurs who purchase the appliances and sometimes from PowerCorner. After a brainstorming session, the Lab and PowerCorner agreed that village associations might be good mechanisms to help promote PUE, negotiate tariffs between developer and community, and safeguard the mini-grid infrastructure. PowerCorner is working to establish these village associations, and have PUE champions play roles within them.

High demand for PUE tools in Kiswahili. The PUE training tools – the user manuals and videos – proved incredibly popular. Off-grid stakeholders welcomed the Lab's user-friendly manuals and video tutorials, commenting on the value of such material, particularly in rural communities. The Lab originally commissioned three videos, but PowerCorner saw so much value in the video tutorials that they commissioned the Lab to produce another two. Over a five-month period, the blender demonstration video received 16,112 views on YouTube and the popcorn machine demonstration received 1,797. The Lab hopes to explore disseminating these tools via WhatsApp groups and to work with entrepreneurs, training institutes and developers to further refine them.

Partnerships for training. The Lab engaged two training institutes to explore models for extending vocational training into tailored curricula for PUE off-grid applications. The institutes already have curriculum assets in place that can be lightly adapted and updated for use with the various PUE opportunities in rural communities. Overall, the institutes showed great interest but cited a lack of budget and top-level push to move forward with a partnership. However, the Lab is confident that with the correct incentives, partnering with national training institutes offers an effective route to scale PUE trainings quickly, for remote communities. Additionally, linking PUE activities with grid expansion programs could garner further political buy-in for PUE programs in general, as many grid expansion programs also face limited demand for electricity in communities that are recently connected.

An ice cream entrepreneur

Rehema Mapui, a female entrepreneur and restaurant owner in Barikiwa saw an opportunity to establish an ice cream business after the PUE training in December 2017 but needed a freezer. After learning how to mobilise capital for her business, she decided to sell cashew nuts with the aim of saving enough to buy a US\$240 freezer. After several months of saving, she successfully bought the freezer, and now earns about US\$4 a day from the ice cream business, making a profit of US\$2 after deducting ingredients and electricity costs. Rehema is also training other women and youth in her village to make ice cream.

The Lab is also looking to build on our partnership with PowerCorner and others, to integrate these learnings into new prototype iterations for 2019. In doing so, the Lab hopes to begin establishing and cataloging more evidence on practical steps needed to establish PUE in communities that have a range of different characteristics and PUE potential, including identifying what community characteristics are needed to amplify PUE demand.

PROTOTYPE 2:

SUSTAINABLE

APPLIANCE

CHAINS

PROTOTYPE 2: SUSTAINABLE APPLIANCE CHAINS



Chang'ombe community mini-grid prototype site

An initiative of E.ON Off-Grid Solutions GmbH, Rafiki Power¹² is a Tanzanian-based mini-grid developer. Starting with its first installation in December 2014 in Komolo and Temeke communities, the company has ten operational mini-grids, supplying electricity to around 4,000 people. Like PowerCorner, Rafiki Power customers are connected to the distribution network via pre-paid smart meters, which allow mobile money payments and automated, remote control of energy consumption.

For this prototype, Rafiki Power selected a 16kW mini-grid that provides electricity to Chang'ombe and Dongo communities in Kiteto district. Both are about 6km from the national electricity grid. Most residents practice farming (79 per cent) or raise livestock (10 per cent); the rest are entrepreneurs and/or work at local dispensaries, schools and local government offices. The main crops include maize, sunflower, millets, sorghum and beans. Baseline information showed that the average annual income ranged from US\$260-867 (TZS 600,000-2,000,000).

Expanding appliance supply chains and after-sales servicing to rural communities

Extending supply chains to these areas mean additional costs for distributors and retailers, who have to transport equipment and appliances over long distances on poorly maintained roads or pay for longer technician visits, which may have to include overnight stays. Remote communities typically have low purchasing power so adding these costs into the appliance price makes this a difficult business case. Acting as convener and implementer across the various

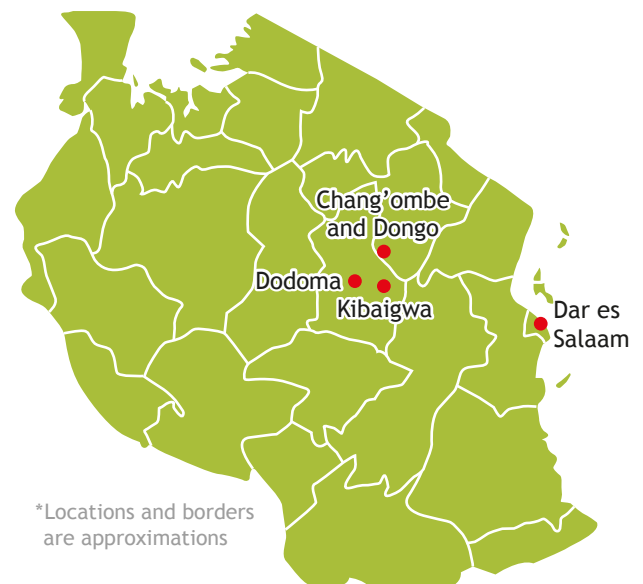


Figure 5: The Lab implemented in Chang'ombe and Dongo communities, which are close to the capital of Tanzania, Dodoma

stakeholders, the Lab aligned and engaged actors across the chain – including suppliers, agents, transporters, distributors, technicians and informal financial institutions – to design appropriate and practical solutions for extending supply chains in this second prototype.

With Rafiki Power, the Lab identified the following steps in the distribution chain as being in critical need of experimentation and iteration:

- Linking appliance supply chains to rural communities
- Enabling after-sales services to isolated communities, and
- Developing manuals and videos to support proper appliance and equipment use.

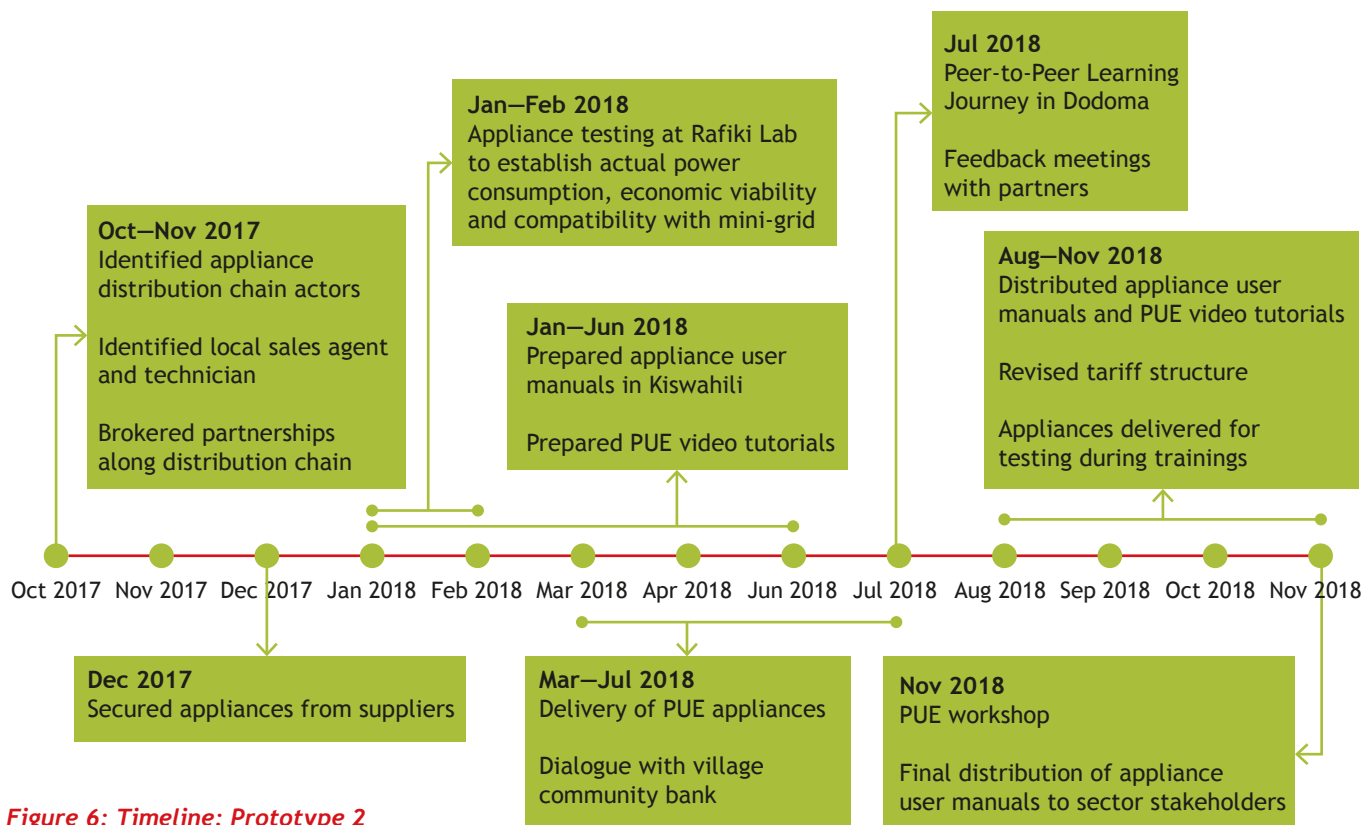


Figure 6: Timeline: Prototype 2

Distribution and after-sales prototyping

In October 2017, the Lab started with an initial stakeholder mapping of distribution and supplier companies in Dar es Salaam that showed potential to serve and provide after-sales services to rural markets. The team also mapped other actors throughout the distribution and retail supply chains, identifying transport companies, agents and wholesalers as potential partners.

The Lab approached five distribution and supply companies in Dar es Salaam and started initial discussions with three that showed an interest in servicing rural communities: Lionsroyal Group Limited, Poly Machines and Hitech International. Hitech and Poly Machines needed special guarantees to move forward. For example, they wanted community entrepreneurs to cover the full costs of transporting appliances to site, allowances for technicians and/or a guarantor to ensure partial or full repayment in case of default. These commitments proved difficult to secure from the various actors.

Lionsroyal, on the other hand, agreed to move forward if the distribution partner could provide 25 per cent of the appliance cost upfront. Thinking 25 per cent upfront feasible for retailers and wholesalers, the Lab decided to proceed with Lionsroyal, brokering agreements along the supply chain to test the possibility of moving appliances the 365km from Dar es Salaam to Chang’ombe and Dongo communities.

Brokering partnerships

To help broker partnerships between distribution companies near the prototype site and Lionsroyal in Dar es Salaam, the Lab approached retailers and wholesalers in a larger, nearby community called Kibaigwa. Two interested retailers and one wholesaler were willing to cover the 25 per cent upfront cost, which Lionsroyal would refund one month after successful on-site appliance delivery. The Lab decided to broker an agreement between Lionsroyal and one distribution agent who showed particular promise. Figure 10 outlines the distribution chain, which covered about 365km.

Securing, testing and delivering appliances

After the signing of the agreement between LionsRoyal and the distribution agent, the Lab secured two PUE appliances from Lionsroyal – a sewing machine and an overlocking machine. LionsRoyal, using a transport company, delivered them to Rafiki Power to test power consumption and compatibility on the mini-grid infrastructure. After testing and because of ongoing delays, the Lab stepped in at this stage and transported the appliances directly to the local agent in the community mini-grid sites in May 2018.

After the distribution agent covered the required 25 per cent upfront costs for the appliances per the agreement, LionsRoyal sent another five appliances from Dar es Salaam through the transporter to the distribution agent 340km away in Kibaigwa. The local agent then brought the appliances to Chang’ombe and Dongo community sites and collected the 25 per cent down payment from the entrepreneur. The local agent then immediately sent the

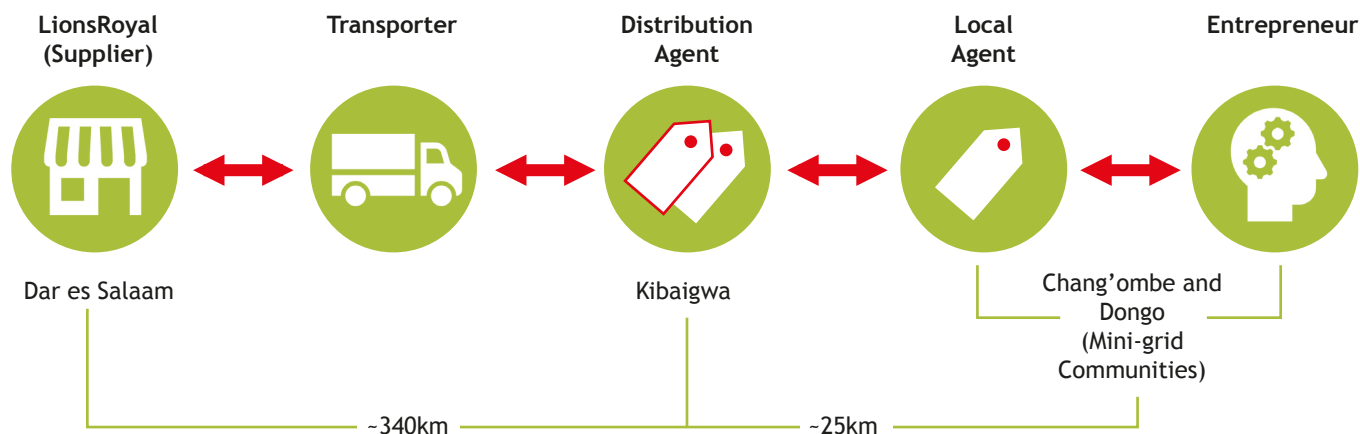


Figure 7: Prototype 2's distribution chain

down payment through mobile money directly to LionsRoyal, and the entrepreneur paid the remaining monthly instalments through mobile money to LionsRoyal.

Entrepreneurial risk and liquidity constraints

While the Lab succeeded in brokering partnerships to extend the supply chain, accessible appliances proved to be only part of the equation. Affordability of the equipment was also a challenge as some entrepreneurs struggled to meet the required 25 per cent down payment to LionsRoyal. Further, issues around agricultural harvests meant that many farmers did not have immediate access to cash from their harvests, which affected the entire economy in the communities. As a result, the supplier agreed to reduce the down payment for community entrepreneurs from 25 per cent to 20 per cent, but the reduction failed to increase uptake. A guarantor would have allowed Lionsroyal to reduce the down payment further, but the Lab's discussions with stakeholders did not identify one in time to iterate further on this prototype. Additionally, community entrepreneurs hesitated to invest without a trial period and warranty coverage. A trial period would have allowed the entrepreneurs an opportunity to test the equipment and their business cases, while warranty coverage would have given some assurances on their investment. Reducing entrepreneur risk through these types of initiatives and instruments will be important in future iterations.



Daniel shows off his overlocking machine for seaming

Bridging the financing gap

The Lab approached a membership-based village community bank (VICOBA) to assess the viability of establishing financial products that are affordable, accessible and attractive to remote communities and their entrepreneurs. The MFIs have a general understanding of the PUE equipment and the business potential. This knowledge helps reduce the costs and risks of lending for such PUE appliances. There was interest from this VICOBA and other smaller financial institutes to lend to entrepreneurs for PUE, but obstacles remain. For example, the VICOBA that the Lab approached in the communities can only work with members and is limited in lending to a maximum of an individual member's total shares, while the appliances and equipment costs were mostly more than any one individual's shares. Other constraints around finance access highlighted during the Dodoma peer-to-peer learning workshop included issues around collateral for loans and lack of credit histories. Few community members have official land deeds to use as collateral and lending for appliances is seen as risky as the appliances are generally considered movable and therefore unviable as loan collateral.

Exploring the technician piece

None of the appliances used in the prototype failed or were defective during the prototyping period. However, the Lab did look closely at identifying and supporting community technicians, eventually engaging with one person who had technical and electrical skillsets and previous experience repairing electrical equipment. Due to the diversity of appliances and applications in the prototype, the Lab introduced the technician to VETA's mobile learning platform, the SOMO app (SOMO is Kiswahili for lesson or subject), to strengthen and formalise his skillsets. Lionsroyal also agreed to connect with the technician, adding him to their technical support WhatsApp group for more integrated advisory and information sharing. Servicing of equipment in distant villages remains a crucial piece to the PUE puzzle that needs further exploratory work.

RESULTS FROM

PROTOTYPE 2

AND LOOKING

FORWARD

RESULTS FROM PROTOTYPE 2 AND LOOKING FORWARD

PUE Champion, Hussein from Mbaya community, conducting an angle grinding demonstration in Barikiwa village

PowerCorner and Rafiki Power are both experimenting with providing appliances on site, delivered through their regular company monitoring visits. However, the successful delivery of these appliances in Prototype 2 proved that it is possible to extend supply chains outside the developers with the right conditions and incentives. If developers can offload the responsibility of appliance accessibility for their communities, this would potentially free up resources to concentrate on their core business of energy delivery.

In a short period, the Lab successfully supported the extension of the appliance distribution chain from Dar es Salaam to Chang'ombe and Dongo, over 365km away, proving that it is possible to lay down supply chains by brokering partnerships and agreements between key players in the distribution chain.

The prototype saw the delivery of seven appliances into the Rafiki Power sites in a short timeframe, establishing five employment opportunities and generating a lot of knowledge and lessons for extending supply chains to remote communities. Indeed, this work highlighted the need to consider the entire appliance and equipment supply chain – from import, distribution and retail to communities, local agents and technicians. There is appetite from actors up and down the distribution chain, but risk mitigation and incentives must be aligned to more firmly establish the chains.

Finance constraints. Finance remains a constraint along the entire chain and there is a need to balance the right portions of risk and reward between stakeholders through own

funds, loans and guarantees. Solving this equation is crucial; although the distributor is willing to hold a lot of the risk, it has limited capital and thus limited ability to offer many appliances through in-house credit facilities. Linking to the finance sector through commercial banks or MFIs and accessing available financial guarantees through government programmes will be important to remove this constraint.

Importance of a knowledge broker. Stakeholders found that support, knowledge and dialogue from an economically disinterested third-party, such as the Energy Change Lab, as crucial to building trust and lowering the heavy costs of relationship building and transactions over long distances. Indeed, Lionsroyal is interested in continuing to strengthen the supply chain but finds the challenges and costs too high to do it alone. The Lab is interested in developing this prototype further to build a stronger functioning distribution chain, with after-sales servicing. One promising way forward is connecting developers and suppliers to establish facilities and agreements together for specific communities that have mini-grids.

Super high-efficiency is the future. An important area around appliances that needs further exploration is establishing a supply of super high-efficiency appliances for smaller solar mini-grids. Higher efficiency appliances reduce overall electricity demand, which is crucial for smaller energy systems where demand must be closely monitored and managed. Higher efficiency appliances also reduce tariff costs for customers and businesses. This would require extensive work identifying, linking and partnering along the distribution chain – from international manufacturers,

importers, suppliers and on down through the chain to the community level. The Lab is looking for international partners to explore the best route to bring this forward.

Youth leadership in rural energy issues

Besides the prototyping work, the Lab facilitated a five-day learning programme for youth around PUE in two communities in Tanzania: Komolo and Ketumbeine. This 'Energy Safari' brought young Tanzanians into thinking and designing for sustainable and people-centered energy systems as well as livelihoods. The programme culminated in the design of five prototypes, which were tested with end-users in the selected communities. For instance, one group of youth examined the availability and affordability of equipment for productive activities in Komolo. They proposed a strategic partnership approach, with financial, technical and mini-grid companies to train and empower community technicians to repair and maintain equipment in the village. This inputted into the design for the second prototype described in this paper.

More details can be found here: <https://energychangelab.org/youth-find-solutions-rural-income-generation-using-solar-mini-grids/>

**LESSONS AND
RECOMMENDATIONS
FROM BOTH
PROTOTYPING
INTERVENTIONS**

LESSONS AND RECOMMENDATIONS FROM BOTH PROTOTYPING INTERVENTIONS



Sifa, a student of one of the Champions in Nakopi village, managed to set up her own tailoring business

While the Lab's sector convening has brought government stakeholders to the table to discuss our prototype learnings as well as other partner learnings, consistent engagement and information sharing between stakeholders continues to play an essential role in pushing the PUE agenda forward. This section contains lessons that emerged from both prototypes and the Lab's peer-to-peer learning and sector convening. It also has recommendations for various stakeholders to increase access to PUE and the benefits it brings. The Lab urges decision makers at all levels to give appropriate policy support to address these lessons and ensure buy-in for the different components of PUE.

1. Community entrepreneurs need risk mitigation

The Lab found that many entrepreneurs are prepared to invest if the risks are properly mitigated. In general, they hesitated to invest before the developers had commissioned the mini-grid systems. Some were concerned that the developer would not ultimately install the system, leaving them with unusable electricity-powered assets. Others were worried about whether the mini-grid could supply adequate electricity to power some of the larger appliances; and this remains a valid concern for the smaller solar mini-grid systems. Official commitments on both sides through demand aggregation such as community sign-ups could possibly help reduce and accelerate investment risks. *Overall, these concerns highlight a need for developers to better engage with communities on proper system sizing and knowledge around off-grid systems.*

With no or low warranty periods on appliances, entrepreneurs hesitated to invest in the equipment. They understandably sought assurances for high-quality appliances in a market that has a reputation for low-quality equipment. Suppliers hesitated to lengthen warranty periods due to the costs of extending these to rural communities, stating that buyers would have to pay for any servicing. Many end-users lack knowledge on what is (manufacturer defect) and is not (end-user negligence) covered under most warranties. Indeed, at the Lab's peer-to-peer workshop in Dodoma, distributors stated that from their experience, most warranty 'claims' were not covered under the contractual agreement. Most claims were due to improper usage of equipment, which is not typically covered under standard warranties. Further Lab prototyping around warranty periods could help address entrepreneurs' concerns and mitigate these risks. Competition between suppliers could also push 'competitive edge' innovations such as offering longer warranty periods. *But in the absence of competition, government incentives or regulations could help mitigate risks on both sides.*

Entrepreneurs also wanted a trial period to experiment with appliances, their business model and market potential. A study conducted on cookstove uptake in Uganda shows that offering cookstove contracts with a free trial period, time payments, and the right to return dramatically increased uptake.¹³ Appliances and cookstoves are very different products and markets, and many larger PUE appliances are more costly investments than efficient cookstoves. However, offering a short trial period to entrepreneurs could be a promising route forward to explore in order to reduce

perceived entrepreneur risk. Developers and distributors could partner to offer such trial periods as well as the ‘right to return’. *Future prototyping work by the Lab and others could help identify the considerations and incentives need for these trial periods and right to return PUE appliances, and their impact on PUE uptake.*



Issa hands out popcorn samples, an example of marketing techniques used by entrepreneurs

2. Entrepreneurs need flexible payment systems and affordable tariffs

Many entrepreneurs could not afford the 25 per cent down payment on appliances due to liquidity constraints tied to seasonal income variations in agricultural communities. Even with a reduced down payment of 20 per cent, uptake did not increase. Payment plans should also consider seasonal income, as some entrepreneurs found it difficult to keep up with full payments, especially in the run-up to harvest season. *The Lab recommends that developers and suppliers promote appliances before and during harvest season, when communities have more available cash.*

Mini-grid tariffs are generally much higher than publicly-subsidised main-grid tariffs. Many entrepreneurs had difficulty meeting these tariffs, especially for appliances that run 24 hours. Some developers use tariff variation to encourage demand smoothing. For solar-powered mini-grid systems, night electricity is more costly to provide due to the high costs of battery storage. Consequently, some of these developers charge a higher night-time rate to load shift or incentivise people to use more electricity during the day, when it is cheaper to produce. However, one tailor cited the higher night-time tariffs as unaffordable and abandoned his attempts at using an electric clothes iron for his original charcoal-heated clothes iron, since he did most of his ironing at night. During the prototyping period, PowerCorner agreed to change the tariffs, which may have helped increase PUE viability. *Future prototyping will require further innovations in tariff structure, including better community engagement around the issue, and possibly short-term subsidisation*

of tariffs to increase demand over the long-term. Indeed, CrossBoundary is currently trialling subsidised tariff structures in Tanzanian mini-grids.

A proliferation of PUE appliances in smaller communities can adversely affect PUE business viability and entrepreneurs’ ability to repay loans and reap livelihood benefits. Increased competition between businesses is good for consumers, as prices for goods and services can drop, but that also affects business profits and viability. *Developers and communities will need to find the right balance of PUE opportunities to ensure that PUE businesses stay sustainable in the long-term.*

3. For PUE Champion networks to work, incentives must be aligned

Although peer-to-peer learning and networking allowed for rapid testing and confidence building in both prototypes, properly aligned incentives helped motivate different actors. Four especially entrepreneurial PUE champions trained 31 of the 45 entrepreneurs. As well as receiving compensation from their trainees, they also plan to further engage them in their own businesses. This highlights some of the essential entrepreneurial skills that the off-grid sector, like most sectors, relies heavily on. Some enjoyed the elevated status of being a PUE champion in their community, which helped motivate them to train others. So, the incentives do not necessarily have to be financial. Some PUE champions could not afford the down payment on appliances, and consequently could not meaningfully train and engage with those interested in PUE knowledge. *The Lab and partners looking to expand on this PUE champions work should further explore what incentives motivate PUE champions to help spur PUE development in communities over the long-term.*

The Lab’s PUE champions WhatsApp group brings together stakeholders to share market information and project news around PUE in Tanzania. 56 members come from a range of



Nuru sells water in Mbaya, taking advantage of the mini-grid electricity for a water pump

institutes, organisations and companies. Having a WhatsApp group drives rapid networking and business connections while also offering a forum for quick insights and ad hoc advice. As far as the Lab knows, this is the largest group of its kind in Tanzania. As well as encouraging ongoing conversations between practitioners, they have shared over 122 documents, reports, videos, photos and relevant PUE links over the last six months. *The Lab hopes to leverage the WhatsApp group further – for example, through more formalised lesson sharing and virtual convening.*



Khalfan Hussein explains Rafiki Power's mini-grid system in Chang'ombe and Dongo

4. Developers need to engage communities in a more productive manner

The two prototypes show that developers need more thorough and formalised community engagement structures to tackle misconceptions and knowledge gaps. One method that emerged from this work is establishing representative community bodies that can negotiate tariffs with developers, better safeguard infrastructure, raise awareness around PUE and mobilise community members as needed. PowerCorner is establishing village power committees that can fulfil this role. Better community engagement helps build trust and understanding and coupled with finance and appliance access could secure greater community commitment and buy-in for PUE and electricity demand in general. *Developers should explore formalising community engagement through agreements and organisational structures, while communities should look to engage developers productively.*

5. Developers and financial institutions could work together to fill the finance gap

Prototype 2 highlighted MFIs limited ability to extend credit and financial instruments for PUE applications in remote communities. Building up financing for PUE in remote areas will probably include efforts to reduce obstacles to accessing finance, coupled with a suite of financial instruments such as concessional financing and guarantees to jumpstart markets.

For example, the National Economic Empowerment Council (NEEC), which coordinates, facilitates and monitors economic empowerment across sectors in Tanzania, has a small and medium-sized enterprise (SME) guarantee scheme that could be tied into PUE efforts. The guarantee scheme ensures repayment in case of default, reducing lending risks to remote entrepreneurs for MFIs and opening finance access to entrepreneurs.¹⁴ *Developers and partners should look to latch PUE into existing financial policies and schemes linked to development in order to help unlock financing for PUE.*

The Lab will continue working with VICOBAs and other finance institutes at local and national levels to troubleshoot affordable financing for PUE entrepreneurs in off-grid communities.

Experience shows that weekly repayments and short payback periods are dissuading entrepreneurs from taking up loans. For example, a longer-term, monthly financing scheme might convince more entrepreneurs to take loans from finance institutes for PUE, which could also translate into more business for finance institutes. *Suppliers, mini-grid developers and finance institutes must engage more closely with entrepreneurs to meet both parties' needs.*

Developers should work with national and micro financial institutes to design useful products to support entrepreneurs and their businesses. For example, Brightlife in Uganda – a social enterprise by FINCA International – links end-user pay-as-you-go product (eg solar lanterns or solar home systems) payments to MFIs, which allows clients access to financial products such as savings accounts that they normally may not be able to access because of barriers or limitations from MFIs.¹⁵ On top of their normal payments to the energy service company, clients can add small amounts that are deposited automatically into a savings account. Clients can continue saving or withdraw for needed investments. At the same time, they are building a payment history with the energy service company, which could be linked into the formal financial system, unlocking further finance possibilities for clients. Through such partnerships, developers could outsource community PUE financing needs, allowing them to concentrate on their core electricity services. *Using their own pay-as-you-go technology (pre-paid meters), mini-grid developers could offer similar solutions and unlock financing for PUE.*

Some appliance suppliers see an opportunity to expand into remote communities but need assurances – such as a guarantor – to lower the risk profile of such markets before they will seriously consider them. Pushing the risk to MFIs via loans coupled with a guarantee could be one way to expand distribution chains, as suppliers would get the full appliance cost upfront. *Developers should work with MFIs and distributors to explore financial instruments like guarantees to enable the extension of supply chains.*

However, servicing equipment remains a challenge both financially and logistically, which merits further exploration between developers, local entrepreneurs, and distributors.

6. Capacity building and mentorship are crucial

Both prototypes highlighted the ongoing need to fill knowledge gaps so entrepreneurs can make better informed decisions regarding investments, operate PUE equipment and run more efficient businesses. Entrepreneurs valued practical, hands-on lessons over the theoretical, which the Lab believes helps to explain why the video tutorials were so popular. The user-friendly appliance manuals in Kiswahili also offer knowledge reinforcement for entrepreneurs who can read and are easy to share electronically via WhatsApp or the internet. Developers and suppliers found these particularly useful for their work. Ongoing advisory support from the Lab also helped build confidence for the entrepreneurs and offered the Lab unique insight into challenges entrepreneurs faced, which helped to tweak the prototypes along the way. *Developers should leverage these tools at their community sites to support entrepreneurs, including regular airing of PUE video tutorials at their community offices, usually near or under solar arrays.*

The Lab engaged training institutes on establishing sustainable PUE training models. Such institutes have the educational assets such as curricula and subject-matter expertise in place to create such materials, as seen in some for the video tutorials in the Lab's partnership with VETA. But adapting modules specifically for off-grid applications takes time and money. Training institutes do not usually have the extra resources needed to create such initiatives, so incentives must be properly aligned to attract them. If future Lab prototypes can establish a viable business model with the correct incentives, there is great promise to build out PUE training for rural communities. *Developers and energy organisations must establish a strong business case for specific PUE off-grid training modules – for example, where entrepreneurs pay for training services – or to lobby governments to establish budgets specifically for PUE capacity building.*

Since training institutes already have locations around the country, deploying and scaling a successful and flexible model throughout their networks should be viable. Leveraging information and communication technology could offer benefits of immediate scale. For example, VETA's app for distance learning offers a way to train remote communities, especially if they can solve issues around connectivity through downloadable modules. *Developers and energy organisations should collaborate and coordinate with capacity building institutes such as the Small Industries Development Organisation (SIDO), VETA, Tanzania Traditional Energy Development Organisation (TaTEDO),*



Mohamed provides a valuable tyre-filling service in Nakopi

E4I, Energy Change Lab and Don Bosco Vocational Training Centre to align PUE capacity building activities under a government agency such as the NEEC or Rural Energy Agency to avoid duplicating efforts, standardise tools and trainings and build out synergies, and rapidly scale.

7. Technical considerations for mini-grids and appliances

Testing appliances and equipment under real-world conditions and constraints, especially for smaller-sized solar mini-grids, proved important to managing loads. When PowerCorner and Rafiki Power tested the appliances, most were compatible. But some – such as milling machines – proved too large for the smaller (16kW) mini-grid systems. Appliances and equipment that are available in remote communities are mostly outdated and inefficient. Global-level efforts for appliance efficiency – such as the Global LEAP Awards, CLASP and the Efficiency for Access Coalition – must be linked to ongoing PUE efforts in remote areas via importation schemes and incentives.¹⁶ Higher-efficiency appliances benefit main-grid suppliers and users as well as off-grid communities, potentially making such efforts more politically viable. Both the Lab's and developers' future efforts should explore how to extend super high-efficiency appliance supply chains into rural communities.

The Ideas to Impact programme field tested high-efficiency refrigeration units in Uganda, identifying several difficulties, including establishing a robust enough methodology, data collection issues and logistics delays.¹⁷ E4I's work with National Renewable Energy Laboratory (NREL) establishes PUE electricity load profiles,⁵ which helps fill in data gaps of appliance operations in real-life conditions. The Lab's prototyping highlights the challenges of building PUE activities on mini-grid systems with relatively limited generation capacity. Industry bodies such as the Africa Mini-grid Developers Association have a role to play in making appliance field-testing data publicly available, to help developers identify the most efficient and reliable appliance profiles for use in remote areas.



The Lab's Frederick Mushi discusses some of the successes and challenges from the prototyping work at the PUE Workshop in November 2018

8. Coordination between stakeholders and PUE promotion is crucial

It is clear that building PUE in remote areas requires involvement from many, especially those outside the energy services industry. Developers and other actors have expressed the need for regularly scheduled dialogues where off-grid stakeholders can constructively share their experiences and work collaboratively to support the mini-grid sector. For example, participants of the Energy Change Lab's workshops and dialogues throughout the prototyping process said this regular convening of partners provided a safe space for these types of discussion. The sector must continue crucial dialogue with government ministries or agencies and other critical supporting structures such as finance and distribution associations through informal convening to build trust and the case for PUE. *Mini-grid developer associations can use such dialogue to co-ordinate and explore financing issues in depth, share information and knowledge and work towards better policy and practice.*

While the Tanzanian government prioritises rural electrification, PUE is not a necessarily specific focus. Our engagements through prototyping, interviews and workshops indicate that partners and stakeholders believe PUE firmly fits within existing national programmes and agendas, such as financing for SMEs, economic development and industrialisation. Linking and possibly formalising PUE into these programmes and agendas will help developers and partner institutes scale up. Opportunities for integration include: the National SME Development Policy, NEEC policy, the National Entrepreneurship Strategy and the National Entrepreneurship Training Framework. The latter provides a framework for teaching in the informal sector, which can guarantee the buy-in of PUE capacity building initiatives. *Developers and energy organisations must look for ways to connect existing frameworks to PUE, while building awareness around PUE with key stakeholders involved in implementation of these policies and frameworks.*

9. Partnerships with the right incentives could be key to scaling up PUE

The Lab's prototypes have revealed the potential power of partnerships. Rafiki Power and PowerCorner are heavily involved in linking the crucial pieces of end-user financing and appliance distribution chains, as well as building technical and business capacity around PUE. Both acknowledge that these activities pull resources and focus away from their core business of energy delivery. The prototyping shows the promise of strong partnerships for building up PUE; pooling resources and close collaboration with specialised institutes in a short time period has had measurable success. Partnerships allow institutes to focus on their speciality, which could be an effective way to quickly build PUE. By working with institutes with national reach, this opens avenues for scaling interventions quickly. *Developers should strengthen partnerships with organisations and institutes that specialise in capacity building, financing and appliance distribution to help build demand while concentrating on delivering energy services.*

The 'KeyMaker' model: an alternative to partnerships?

Another rural mini-grid operator, JUMEME Rural Power Supply, established a dedicated PUE unit servicing its initial mini-grid site on Lake Victoria in 2016. The company buys appliances on behalf of the customer or entrepreneur and then determines a loan structure. After JUMEME has tested and installed the appliance, the customer signs a contract and the JUMEME PUE unit facilitator offers post-installation service support. JUMEME says that this approach has enabled a greater uptake of appliances at their mini-grid site, with a total of 498 PUE customers across 11 community mini-grid sites. However, the operator is unsure of the sustainability of offering combined finance and appliance distribution as a mini-grid company.

As a result, they are experimenting with an approach they call the 'KeyMaker' model, in which a subsidiary company establishes businesses around existing community value chains and resources. For example, the company will buy fish from local fishers, freeze it on site and then transport it to Dar es Salaam for sale. This diversifies revenue away from just electricity services, which strengthens the overall business and allows subsidiary specialisation. This model also aims to give steady, non-seasonal income employment to communities.

Source: Correspondence with JUMEME (2018) and Fleming (2018)¹⁸

LOOKING FORWARD



Hussein, PUE Champion in Mbaya, conducting a welding demonstration in Barikiwa

Built on thorough field research and guided by ongoing iteration from stakeholders, the Lab's prototyping has been successful in generating and disseminating new PUE knowledge. This includes knowledge around bridging the skills gaps, fostering sustainable appliance supply chains, building partnerships and sharing learning.

This report documents our achievements so far but there is still much more work to do. Others who have extensively worked in Tanzania – such as E4I – have done important and complementary work in parallel on PUE entrepreneur business and technical cases. But the Lab can do more to bridge and build on this learning. To this end, the Lab aims to establish a holistic and practical 'how-to' approach to catalyse PUE businesses that work for specific local contexts, tailoring and applying combinations of capacity building, longer-term mentorship, financial access and linking different parts of the PUE appliance distribution chains.

The Lab will pursue experimental evidence and data to develop this approach and test its effectiveness for replication and scale. Overall sector coordination must

continue to improve and stakeholders must forge new partnerships to catalyse PUE at scale. The Lab will continue PUE dialogues and expert convening will be stepping up advocacy efforts to help catalyse PUE development in the areas highlighted in this prototyping work. Indeed, across the Lab's PUE activities, stakeholders – from communities and entrepreneurs to mini-grid developers and MFIs – have expressed a need for a semi-permanent platform or continued convening of stakeholders to bring together sector learnings and consolidate sector messaging for policymakers and investors.

To this end, the Energy Change Lab will continue to provide a PUE convening and learning function to help the sector to move forward. The Lab will also continue working with others, brokering and seeking new partnerships to continue building PUE knowledge and partnerships to scale impacts going forward with the ultimate aim of building self-sufficient individuals and networks who achieve people-centred and equitable energy systems.

ANNEX A: THE ENERGY CHANGE LAB PROCESS FOR PROTOTYPING PUE

Prototyping steps	Process	Methods/tools
Defining	<p>System sensing/problem analysis, consisting of:</p> <ul style="list-style-type: none"> Forming ideas through research on PUE and site visits Initial conceptualisation through meetings with relevant stakeholders. 	<p>Desk research. Field/site visits and research. One-on-one meetings. Participatory workshop/s with stakeholders.</p>
Exploring	<p>Situational analysis and partnership building:</p> <ul style="list-style-type: none"> Establishing the key prototype partners Detailed mapping of local stakeholders and discussions to build potential partnerships for empirical test of each idea/s. <p>Prototype design:</p> <ul style="list-style-type: none"> Identifying probable solutions/design of prototypes. 	<p>Field/site visits. One-on-one meetings with potential partners. Forming the core team. Establishing partnerships.</p>
Connecting	<p>Reach out to relevant stakeholders and actors to be involved in implementing the prototypes, agreeing key actions, roles and responsibilities. Includes answering some questions developed with a prototyping canvas.</p>	<p>Meetings to concretise partnerships for prototype implementation both on and off site. Memoranda of understanding with partners.</p>
Prototyping	<p>Prototype implementation:</p> <ul style="list-style-type: none"> Gather additional data and detail design of prototype that includes Partner coordination, technical advisory, and so on Implementation plan activities and deployment of resources. <p>Prototype refinement:</p> <ul style="list-style-type: none"> Feedback with partners and stakeholders to redesign or refine the prototype. 	<p>Collect data on site. Develop tools. Linkages to new stakeholders as needs emerge. Trainings, meetings, workshops.</p>
Unleashing	<p>Finalising prototypes and disseminating learnings.</p>	<p>Draw up lessons learnt. Discuss with partners and stakeholders through peer-to-peer workshops and/or meetings. Village meetings (entrepreneurs, others). Final workshop. Prototyping guideline.</p>

ANNEX B: LIST OF KEY PUE STAKEHOLDERS IN TANZANIA

Institutions	Brief overview and role in PUE
Government	
Energy and Water Utilities Regulatory Authority (EWURA)	Established by the EWURA Act Cap 414, it is responsible for technical and economic regulation of the electricity, petroleum, natural gas and water sectors and for approving independent projects, tariffs and design of regulations. www.ewura.go.tz
Ministry of Agriculture	In charge of delivering agricultural and cooperative services, providing a conducive environment to stakeholders, building local government authority capacity and facilitating the private sector to contribute effectively to sustainable agricultural production, productivity and cooperative development. www.kilimo.go.tz/index.php/en
Ministry of Energy	Responsible for facilitating the development of the energy sector in Tanzania. www.nishati.go.tz/
Rural Energy Agency	An autonomous body under the Ministry of Energy whose role is to promote and facilitate improved access to modern energy services in rural areas of mainland Tanzania. www.rea.go.tz/
Tanzania Bureau of Standards	An autonomous body under the Ministry of Industry and Trade, established by the Standards Act No.3 (1975) as the National Standards Institute. It is mandated to measure the quality of products of all descriptions and promote standardisation in industry and commerce. www.tbs.go.tz/
Development partners	
International Finance Corporation	Development partner and funder for energy/PUE projects, it is developing database for PUE in Tanzania. www.ifc.org
European Union	Development partner and funder for energy/PUE projects. https://eeas.europa.eu/delegations/tanzania_en
Embassy of Norway	Development partner and funder for energy/PUE Projects. www.norway.no/en/tanzania
United Nations Industrial Development Organization	Development partner and funder for energy (hydro, biomass)/PUE projects. www.unido.org

Mini-grid developers and energy providers

European Committee for Training and Agriculture (CEFA)	Generates and distributes reliable hydropower, conducts community awareness campaigns and supports PUE projects. Also offers a living example of an anchor business community (ABC) model in making mini-grids sustainable.
Ensol Tanzania Limited	Supplier of solar products, related components and technical support. Also generates and distributes reliable power and conducts community awareness campaigns. https://ensol.co.tz/
JUMEME Rural Power Supply	Generates and distributes reliable power, conducts community awareness campaigns and PUE training, pre-finances and delivers appliances. www.jumeme.com/
Mwenga Hydro	Generates and distributes reliable hydropower, conducts community awareness campaigns and supports PUE enterprises on site.
PowerCorner Tanzania Limited	Offers reliable and sustainable energy services through off-grid mini-grids serving rural customers in Tanzania and Zambia. Also pre-finances and delivers appliances, which customers pay off in instalments over several months. http://powercorner.com/
Rafiki Power Tanzania Limited	Offers reliable and sustainable energy services through off-grid mini-grids serving rural customers in Tanzania. Also conducts community awareness campaigns and pre-finances and delivers appliances, which customers pay off in instalments over several months. www.rafikipower.com/
Simusolar	Provides and finances accessible, affordable and energy-efficient systems designed for smallholder farmers and fishermen. www.simusolar.com
Sepon Limited	Supplier of solar products, related components, PUE appliances and technical support. www.sepon.co.tz

Training

Afi Green Equipment Co. Ltd	Develops, manufactures and supplies modernised poultry farming equipment. www.afigreenequipment.com
Hitech International	An engineering group that manufactures and supplies machines and equipment. Also leases equipment and machinery to those who are willing and capable of starting and developing small and medium-sized industries.
Lionsroyal Group Limited	An engineering group that supplies machines and equipment and provides maintenance services.
Polymachines	Conducts research and development, produces and sells large and medium-size grain grinding equipment and processing machinery. www.poly-machine.com
Vetah Hardware Tools and Machines	Supplies a wide range tools and machines from well-known and best-reputed brands across the world. www.vetah.net

Non-profits

Energy Change Lab	Enables pioneers in and outside the energy sector to design, test and learn about interventions that promote PUE. www.energychangelab.org/
Energy 4 Impact	Supports businesses that provide energy access and services in off-grid and on-grid communities through a wide range of services that are tailored to each enterprise, from micro to small enterprises as well as project developers. www.energy4impact.org/
SELCO Foundation	Seeks to inspire and implement socially, financially and environmentally inclusive solutions by improving access to sustainable energy through a holistic ecosystem approach. https://selcofoundation.org/
Tanzania Renewable Energy Association	Network of renewable energy stakeholders that promote sustainable development of renewable energy technologies in Tanzania, training youth at artisan level and providing them with work tool sets among other activities. www.tarea-tz.org/
Tanzania Traditional Energy Development Organisation	Implements sustainable energy projects and promotes the use of sustainable energy for productive activities (industrial and agriculture), consumptive activities (households) and institutional uses (education, health, water, communities and so on). Also provides energy-related consultancy services. www.tatedo.org/
TANGSEN – Tanzania Gender and Sustainable Energy Network	A professional network advocating for women’s empowerment and increased access to modern energy technologies and services in Tanzania. www.ngsen.org

Financing

Equity for Tanzania Ltd	A finance company focusing on equipment loans/financial leasing, (with no collateral except for the equipment itself) to SMEs and farmers in Tanzania. www.efta.co.tz/
Bank of Africa	Part of the Bank of Africa Group, which operates through a network of commercial banks in 18 African countries. Has signed a US\$12 million credit facility agreement for renewable energy and energy efficiency projects in Tanzania. http://tinyurl.com/y2pejjq8
CRDB Bank	Provides different financial services and has customised products for SME financing. https://crdbbank.co.tz/
National Microfinance Bank	A fully-fledged retail and commercial bank offering banking services to individuals, SMEs and large corporates. Has specific product for individuals, SMEs and farmers. www.nmbbank.co.tz
Private Agricultural Sector Support Trust	Established in 2000 to stimulate investment and growth in commercial agriculture and related sectors by providing financial and business development services. http://pass.or.tz/
TIB Development Bank	Managing the Renewable Energy Company's credit line facility under Tanzania–Rural Electrification Expansion Project (TREETP) and competitive private sector incentives such as the Result-based Finance (RBF) fund for renewable energy projects. www.tib.co.tz/
Village community banks	The lending model in rural areas, often suitable for and effective in catalysing local developmental initiatives through efficient operation of savings and credit services.
Vision Fund – Tanzania	Provides microfinance products and services designed to serve customers' needs and unlock the economic potential for communities with limited means. www.visionfund.org/2260/where/africa/tanzania/about-us/

Training

Small Industries Development Organisation	Established by Act No 28 of 1973 and charged with the broad task of promoting the development of small-scale industries in Tanzania. Develops, creates, promotes and sustains the indigenous entrepreneurial base by providing training, financing, incubation centres, technical assistance and consultancy services.
Twende Social Innovation Centre	Identifies local needs, engineers new technology solutions, empowers entrepreneurs, offers business support and encourages local innovation. www.twende-tanzania.org/
Vocational Educational and Training Authority (VETA)	Established by Act of Parliament No 1 of 1994 and charged with the broad tasks of coordinating, regulating, financing, promoting and providing vocational education and training in Tanzania. Offers various vocational learning skills via a mobile learning app. www.veta.go.tz
Don Bosco Vocational Training Centre	Offers technical training in carpentry, electrical, mechanics, secretarial, welding together with aluminium works and tailoring. Also offers skills development and apprenticeship training. http://donboscoysterbay.co.tz/

Information Portals

MSMEs Information Portal	A 'one-stop shop' for all information related to MSME development, which was established by TPSF in collaboration with FSDT. The portal enables entrepreneurs to access important tools for business management, sources of finance, know-how on markets, business networks and above all, self-training materials for those who would like to start business ventures for the first time as well as those already doing business, to acquire more skills and experience. The information provided is in Kiswahili and English languages. https://entrepreneurs.or.tz/
BESP Mobile Platform	Developed by Tanzania Digital Youth Empowerment Program (TADIYE), the app provides an online learning platform that enables entrepreneurs to acquire business management skills, funding and enable them to be innovative in optimising opportunities provided by the digital economy in wealth maximisation and jobs creation. The information provided is in Kiswahili and English languages.

REFERENCES

- ¹See Basil, S et al. (2017) The Energy Change Lab: building a sustainable and people-centred energy system". Tanzania 2017. See www.energychangelab.org/assets/2017/03/Strategy-Energy-Change-Lab.pdf
- ²See www.energychangelab.org
- ³Best, S and Garside, B (2016) Remote but productive: using energy access investments to catalyse enterprises and income in Tanzania's rural communities. Working paper, Energy Change Lab.
- ⁴Johnstone, K (2019) Off-grid productivity: powering universal energy access. Policy Brief, IIED.
- ⁵Booth, S et al. (2018) Productive use of energy in African micro-grids: technical and business considerations.
- ⁶www.energychangelab.org/productive-use-energy-can-generate-growth-tanzanias-rural-economy/
- ⁷www.energychangelab.org/fast-tracking-productive-use-of-energy-solutions-through-rapid-prototyping/
- ⁸Malaki, B (2017) How productive use of energy can generate growth in Tanzania's rural economy. See <https://energychangelab.org/productive-use-energy-can-generate-growth-tanzanias-rural-economy/>
- ⁹Oparaocha, S (2014) Training manual: gender, productive uses of electricity and business development skills.
- ¹⁰Wallace, H (2016) Power from the people: rural electrification brought more than lights. See <http://americanhistory.si.edu/blog/rural-electrification>
- ¹¹Rafiki Power and PowerGen (another Tanzania-based mini-grid developer) are engaged in talks regarding a potential merger of the two mini-grid companies' operations in Tanzania.
- ¹²Levine, D et al (2016) What impedes efficient adoption of products? Evidence from randomized variation in sales offers for improved cookstoves in Uganda.
- ¹³Kashuliza, A (2013) Economic empowerment to reduce poverty. Policy brief. NEEC.
- ¹⁴<https://finca.org/our-work/social-enterprise/brightlife/>
- ¹⁵<https://globalleapawards.org/>, <https://clasp.ngo/> and <https://efficiencyforaccess.org/>
- ¹⁶Kuria, D et al (2019) Learning paper: the challenges of field-testing off-grid refrigerators. See https://storage.googleapis.com/e4a-website-assets/Ideas-to-Impact_Fridge_2019.pdf
- ¹⁷Fleming, P (2018) JUMEME's unique mini-grid model gains traction in Tanzania. See www.seforall.org/content/jumeme-unique-mini-grid-model-gains-traction-tanzania

WWW.IIED.ORG - @IIED
WWW.HIVOS.ORG - @HIVOS

